UNITED NATIONS
ECONOMIC AND SOCIAL COUNCIL

Distr.
LIMITED

E/ECA/SDEHSD/NDPPA/84/WP.1
February 1984

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA

Regional Meeting on Natural Disaster Prevention and Preparedness in Africa*

Addis Ababa, 24-25 February 1984

NATURAL DISASTER PREVENTION AND PREPAREDNESS IN AFRICA

.....

* Organized under the joint auspices of the United Nations Economic Commission for Africa (ECA), Organization of African Unity (OAU) and the Office of the United Nations Disaster Relief Co-ordinator (UNDRO).

OFFICE OF THE UNITED NATIONS DISASTER RELIEF CO-ORDINATOR
(UNDRO)

NATURAL HAZARDS IN AFRICA

Working Paper
for the ECA/OAU/UNDRO Meeting
on Natural Disaster Prevention and Preparedness

Addis Ababa
24 - 25 February 1984

Geneva

December 1983

UNDRO/84/1
GE.84-00219

CONTENTS

	Page
Foreword	iii
1. Introduction	1
2. Natural disasters in Africa	2
2.1 Tropical cyclones	2
2.2 Floods	2
2.3 Earthquakes	3
2.4 Volcanic eruptions	4
3. Hazard assessment	6
4. Preventive measures	12
5. Disaster preparedness	15
6. Role of the United Nations and its Specialized Agencies	18
7. Strategy and recommendations	21
Bibliography	
Annex	
Figures 1 - 2	
Map of natural hazards in Africa	

1. INTRODUCTION

In terms of economic loss and human suffering, drought and desertification are undoubtedly the greatest natural hazards faced by the African countries. However, a significant toll of life and property is taken each year by other natural disasters which are the subject of the present paper. Tropical cyclones, floods, earthquakes and volcanic eruptions occur frequently in various parts of the continent and cause serious disruption to social and economic activity, sometimes with consequences which endure long after the event. In purely economic terms, the losses that they inflict may represent a significant percentage of the gross national products of the countries affected. They often occur with little or no warning.

It may be said that these natural phenomena are not dangerous in themselves but only insofar as human beings make them so. Indeed, the losses that they inflict depend not only on the magnitude or intensity of the phenomena themselves but on the nature and value of the objects (houses, buildings, etc.) exposed to them and on the vulnerability of these objects to the forces exerted on them by wind, flood, earthquake ground motion, etc. The natural phenomena themselves are generally beyond human control, but much can be done by appropriate choice of sites for settlement or investment, by reducing vulnerability and by improving preparedness, to mitigate their effects and reduce losses.

Any systematic attempt to reduce the losses caused by natural disasters will therefore comprise three main elements:

(a) Identification and assessment of the hazards;

(b) Disaster prevention through long-term protective measures to reduce vulnerability;

(c) Preparedness to deal with disaster situations, including temporary protective measures.

The general problem of natural disasters in Africa will be analyzed in this paper under these main headings.

2. NATURAL DISASTERS IN AFRICA

2.1 Tropical cyclones

Tropical cyclones are severe storms that develop over the oceans, generally between 10° and 20° north or south latitude and in areas where the ocean surface temperature is at least 26°C. In these storms, winds of up to 200 km/hour circulate round the storm centre (or "eye"), anticlockwise in the northern hemisphere and clockwise in the southern hemisphere. The storm centres move at speeds generally less than 50 km/hour, their direction of movement being controlled by winds in the upper levels of the atmosphere.

In the southern Indian Ocean, eight tropical cyclones occur, on the average, each year between January and June; they are practically unknown during the second half of the year. As they move westward across the ocean, they may affect successively the islands of Mauritius, Réunion, Madagascar and the Comoros and then strike the African continent on the coasts of Mozambique or Tanzania. A few penetrate inland as far as Malawi. The Seychelles lie too near the Equator to be struck directly by these cyclones but are sometimes affected by the high winds and rain on their periphery.

When a tropical cyclone crosses a coastline and moves inland, it often causes serious damage due to the force of the wind, the flooding consequent on heavy and intense rainfall and, in coastal areas, by the rise in sea-level caused by the low atmospheric pressure and the piling-up of water against the coast by the strong winds. The greatest damage is usually done by flooding.

Because of its north-south extension across the track of the Indian Ocean cyclones, Madagascar is the country most often affected by these storms. On several occasions in recent years, individual cyclones have caused 50 or more deaths and damage exceeding $10 million; and several such storms strike Madagascar, on the average, each year. The islands of Mauritius and Réunion are also affected almost each year by at least one cyclone, causing death, injury and severe economic losses. Mozambique and Tanzania on the African continent are somewhat less exposed, but even in these countries severe damage and loss of life are caused by cyclones every few years.

2.2 Floods

In terms of their physical, spatial and temporal characteristics and their impact on human activities, two main types of flood may be distinguished:

(i) floods in the great river basins such as the Congo, Niger, Nile and Zambezi; and

(ii) local flash-floods resulting from unusually heavy local rainfall.

Four large river systems drain together over 20% of the land area of continental Africa, and their flow amounts to more than 50% of the total run-off from the continent. With the exception of the Congo, they have all developed extensive flood plains whose rich alluvial soils support large agricultural populations. The valley of the Nile provides an outstanding example of human adaptation to a regime of periodic flooding. In recent years large dams have been built to regulate the flow of the Nile, the Niger and the Zambezi (and of the Volta in Ghana) but the full ecological and social effects of these dams have yet to be fully studied.

No country in Africa can be considered entirely free of the risk of sudden, local flash-floods. The more arid the region, the more variable is the rainfall from year to year, and the more rapid is the surface run-off when heavy rain does occur. Rain from convective storms may generate destructive floods within a matter of hours, causing severe damage and loss of life in settlements whose inhabitants have little or no warning of impending disaster. Some of these floods are associated with the passage of cyclones or frontal disturbances, but many others are caused by local convective storms whose occurrence cannot easily be forecasted.

In recent years, significant damage and loss of life have been inflicted by flash-floods in Algeria (e.g. El Eulma, 1981; Annaba, 1982), in Djibouti (1977, 1980, 1981), in Upper Egypt (1979), in Kenya (1971), in Madagascar (January 1982), in the Sudan (Al-Jazirah, 1979), in Tunisia (Sfax, October 1982) and in Zambia (Lusaka, February 1978). As distinct from the periodic flooding in the great river basins, such flash-floods are entirely negative in their economic and social effects. They destroy crops, damage human settlements and often take a heavy toll of human and animal life, without bringing any long-term benefit to the land; they wash away light soil and deposit only boulders and coarse sediments.

2.3 Earthquakes

With the exception of some isolated earthquakes such as those which occurred in Accra (Ghana) on 22 June 1939, in Barce (Libya) on 21 February 1963, and in the Gaoal region of Guinea on 22 December 1983, seismic activity in Africa appears to be restricted to two well-defined zones:

(i) the Maghreb zone in northwest Africa, extending from the Atlantic coast of Morocco through northern Algeria to Tunisia; and

(ii) the East African Rift zone, running from the eastern Mediterranean through the Red Sea, Ethiopia and Djibouti, and extending southward

along both branches of the African Rift through Kenya, Uganda, Rwanda, Burundi, Tanzania, Zambia and Malawi into Mozambique, Zimbabwe and Botswana.

Of these two zones, that in northwest Africa is by far the most active and has been the site of several major earthquakes in the present century: Agadir (Morocco), 29 February 1960; El Asnam, now Ech Chlef (Algeria), 9 September 1954 and 10 October 1980. Although no single earthquake in East Africa has been as destructive of life and property as these, several damaging events of magnitude greater than 6 have occurred in recent years: Wollo district (Ethiopia), May-September 1961; Subukia (Kenya), 6 January 1928; Toro district (Uganda), 20 March 1966; Moulu (Tanzania), 7 May 1964.

In addition, some earthquakes appear to have been triggered by the filling of large reservoirs, particularly those created by the Kariba Dam on the Zambezi and the Aswan High Dam on the Nile. However, these events have not been strong enough to cause significant damage or loss of life.

The fact that the loss of life from earthquakes in East Africa has so far been insignificant compared with that in northwest Africa must be attributed mainly to the relatively low density of population in East Africa. On the other hand, the generally poor quality of housing in this region and the complete absence of any anti-seismic building codes mean that the region is very vulnerable to attack by any future earthquakes that may occur.

2.4 Volcanic eruptions

Africa has 44 active or dormant volcanoes judged to be liable to future eruptions. Most of these are located in or near the East African Rift system, running from the Red Sea, Ethiopia and Djibouti southward through Kenya and Tanzania (see Figures 1 and 2). A more westerly cluster of volcanoes, including two of the most regularly active and destructive on the continent, lie in the western branch of the Rift in eastern Zaïre close to the border with Rwanda. The only other potentially active volcanoes in continental Africa are Mount Cameroon and two in the Tibesti (Chad). On the other hand, there are several very active volcanoes in the island countries of the Indian Ocean, notably Karthala on Grande Comoro and Piton de la Fournaise on Réunion.

Of these volcanoes, 21 have been active in historical times and five eruptions have caused fatal casualties: those of Dubbi and Afdera (both in Ethiopia) in 1861 and 1907 respectively, Nyiragongo (Zaïre) in 1977, and Karthala (Comoros) in 1883 and 1904. Another volcano in Zaïre (Nyamuragira) has erupted twice in the present century, causing damage to property, while Mount Cameroon erupted in 1909 and again in 1922, producing lava flows which

reached some populated areas near the coast.

The most dangerous eruptive phenomena at the African volcanoes are mud flows (lahars) and heavy falls of hot ash. Lava flows are destructive but generally less dangerous to human life. Nevertheless, a sudden and extremely fluid lava flow from Nyiragongo during its 1977 eruption covered an area of 20 km^2 in less than an hour, killing several hundred people and destroying over 400 houses. On Mount Cameroon, the principal danger appears to result from sudden flows of mud, generated by the action of rain on the volcanic ash and scoria accumulated on the flanks of the volcano.

3. HAZARD ASSESSMENT

The first step in any action to reduce damage and loss of life in natural disasters is to assess the hazards, that is to say the probabilities of occurrence of the various potentially destructive phenomena. If individual events can be predicted and warnings issued, then so much the better.

3.1 Tropical cyclones

The areas liable to be affected by tropical cyclones are by now well known, and the probability of any particular place being struck by one or more of these storms in a given period of time can be calculated with some precision. Long-term protective measures, such as the adoption of codes for wind-resistant construction, can be planned and implemented in accordance with the level of the hazard.

Furthermore, modern systems of detection, especially meteorological satellites and weather radar, make it possible to detect and locate tropical cyclones soon after their formation, to track their movements and to issue warnings several hours or even days in advance, to the areas they threaten. At present, the meteorological services of Malawi, Mauritius, France (Réunion) and Tanzania have the equipment necessary for the reception of pictures from meteorological satellites, though some services lack experience in the interpretation of these pictures. Madagascar, Malawi, Mauritius, Mozambique and France (Réunion) have weather radars, but in some of these countries maintenance has suffered from the difficulty of obtaining spare parts.

Regional co-operation between neighboring countries is of the first importance in cyclone tracking and forecasting. For this reason, the countries affected by cyclones in the southwest Indian Ocean (Comoros, France (Réunion), Madagascar, Malawi, Mauritius, Mozambique, the Seychelles and Tanzania) have set up a regional Tropical Cyclone Committee under the auspices of the WMO. This Committee has elaborated a Tropical Cyclone Operational Plan which defines the forecasting and warning responsibilities of all the co-operating members. Arrangements are made for the exchange of information and data, with a view to attaining the most effective cyclone warning system for the region. The Committee meets annually in one or other of the co-operating countries.

3.2 Floods

The identification and mapping of the zones liable to flooding present a variety of problems. In general, relevant data can be obtained from three main sources:

TABLE - 1 REGION I (AFRICA): PRECIPITATION OBSERVATION NETWORKS

Sub-Column a - Records duration less than 5 years
Sub-column b - records duration between 5 and 10 years
Sub-column c - Records duration more than 10 years
Sub-column d = a + b + c

(1) State/Terrotory	(2) Area km²	(3) Year of reporting (a)	(4) No. of non-recording gauges and totalizers (a)	(b)	(c)	(d)	(5) No. of recording gauges (a)	(b)	(c)	(d)	(6) Density km² x 10³/stn.
Algeria	2,381,741	1972-75	314	296	377	987	43	15	26	84	2.2
Angola	1,246,700		185	167	212	564	23	1	22	46	2.0
Benin	112,622					(65)				(14)	1.4
Botswana	600,372										
Burundi	27,834	1972-73	23	25	47	100	11	5	3	19	0.2
Central African Republic	622,984	1972-73		12	76	88	3	2	1	6	6.6
Canary Islands	7,300	1972-73				523				6	0.01
Cape Verde*	4,033										
Chad	1,284,000	1972-73	14	3	77	94	8		4	12	12.1
Comoros	2,171	1972-73	19	11	20	50	5		3	8	0.04
Congo*	342,000										
Egypt	1,001,449	1972-73	1	1	41	43	1	9	14	24	14.9
Equatorial Guinea*	56,102										
Ethiopia	1,221,900	1972-73	241	204	86	531	24	20	1	45	2.1
Djibouti	22,000	1972-73	5	3	14	22	0	1	1	2	1.0
Gabon	267,667					(61)				(9)	3.0
Gambia	11,295					(16)				(4)	0.6
Ghana	238,537	1972-73	29	88	342	459	17	14	36	67	0.5
Guinea	245,857					(43)				(6)	5.0
Guinea Bissau*	36,125					(17)				(12)	1.2
Ivory Coast*	322,463										
Kenya	582,646	1972-73	178	166	605	949	4	7	27	33	0.6
Lesotho	30,355	1976	25	5	9	39			7	7	0.8
Liberia	111,369					(30)				(1)	3.6
French Dept. of Réunion	2,510	1972-73	14	33	77	124	9	9	10	28	0.21

Table 1 (continued)

(1) State/Territory	(2) Area km^2	(3) Year of reporting	(4) No. of non-recording gauges and totalizers (a)	(b)	(c)	(d)	(5) No. of recording gauges (a)	(b)	(c)	(d)	(6) Density $km^2 \times 10^3$/stn
Libyab Arab Republic	1,759,540	1972-73	4	32	111	147		1		1	11.9
Madagascar	587,041	1972-73	42	8	509	599	0	0	27	27	1.0
Malawi	118,484	1972-73	172	63	175	410	2	1	17	20	0.3
Mali	1,240,000	1972-73	15	9	148	172	5	1	6	12	5.7
Mauritania*	1,030,700					(33)				(6)	25.0
Mauritius	2,045	1972-73			257	257		3	3	6	0.000
Morocco	446,550					(300)				(24)	1.4
Mozambique	783,030	1972-73	164	77	653	894	13	7	26	46	0.8
Namibia*	324 292										
Niger	1,267,000	1972-73	6	26	68	100	0	11		11	11.4
Nigeria	923,768	1972-73	20	600	430	1050	0	20	30	50	0.8
Rwanda	26,338	1972-73	66	33	58	157	33	9	1	43	0.1
Senegal	196,192	1972-73	3	35	68	106	3	0	7	10	1.7
Sierra Leone*	71,740										
Somalia*	637,657										
Zimbabwe	390,580					(1111)				(37)	10.3
Sudan	2,505,813	1972-73	125	199	847	1171	10	29	19	53	2.0
Swaziland*	17,363					(45)					0.4
Togo	56,000	1972-73	1	25	65	91	2	9		11	0.5
Tunisia	163,610	1972-73	92	234	274	677				100	0.2
Uganda	236,036	1972-73	204	77	294	575				33	0.4
United Republic of Cameroon	475,422	1972-73	50	75	60	185		2	6	8	2.5
United Republic of Tanzania	945,087	1972-73	327	180	443	950	3	2		10	1.0
Upper Volta	274,200	1972-73	65	33	37	135	7	3	3	13	1.4
Western Sahara	266,000	1972-73				2				2	36.5
Zaire	2,345,409	1972-73			223	223	0	0	44	44	8.0
Zambia	752,614	1972-73	129	150	435	714	5	29	27	61	1.0

* Information not received

TABLE 2 REGION I (AFRICA): SURFACE WATER OBSERVATION NETWORKS - DISCHARGE

Sub-column a - Records duration less than 5 years
Sub-column b- Records duration between 5 and 10 years
Sub-column C - records duration more than 10 years
Sub-column d= a + b + c

(1) State/Territoty	(2) Area Km^2	(3) Year of reporting	(4) Discharge stations								(5) Total	(6) Density $Km^2 \times 10^3$/stn
			Recording No.				Non-recording No.					
			(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)		
Algeria	2,381,741	1972-75					90	20	50	160	160	14.9
Angola	1,246,700		14	85	24	123		3	2	5	128	9.7
Benin	112,622										(30)	3.8
Botswana	600,372											
Burundi	27,834	1972-73					14			14	14	2.0
Central African Republic	622,984	1972-73	4	1		5	44	1	18	63	63	9.1
Canary Islands	7,300	1972-73									37	0.2
Cape Verde*	4,022											
Chad	1,284,000	1972-73					7	1		8	8	160.5
Comoros	2,171	1972-73									0	
Congo*	342,000											
Egypt	1,001,449	1972-73	2	2	119	123	3	29	27	59	182	5.5
Equatorial Guinea*	56,102											
Ethiopia	1,221,900	1972-73	50	12		62	22	9	18	49	111	11.0
Djibouti	22,000	1972-73					2			2	2	11.5
Gabon	267,667										(43)	6.2
Gambia	11,295										(7)	1.6
Ghana	238,537	1972-73					67	26	23	116	116	2.1
Guinea	245,857										(34)	7.2
Guinea Bissau*	36,125											
Ivory Coast*	322,463											
Kenya	582,646	1972-73	6	8	17	31	2	37	112	151	182	3.2
French Department of Réunion	2,510	1972-73								15	15	6.2

Table 2 (continued)

(1) State/Territory	(2) Area km²	(3) Year of reporting	(4) Discharge stations: Recording No. (a)	(b)	(c)	(d)	Non-recording No. (a)	(b)	(c)	(d)	(5) Total	(6) Density km² x 10³/stn
Lesotho	30,355	1976	7	12	14	33	1			1	34	0.9
Liberia	111,369										(11)	10.1
Libyan Arab Republic	1,759 540	1972-73									(30)	58.7
Madagascar	587,041	1972-73									(100)	5.9
Malawi	118,484	1972-73	4	2	10	16	51	21	85	157	173	0.7
Mali	1,240,000	1972-73									(28)	44.3
Mauritania*	1,030,700											
Mauritius	2,045	1972-73	13	5	5	23	5	6	4	15	38	0.05
Morocco	446,550										(141)	3.1
Mozambique	783,030	1972-73	2	6	21	29	20	34	109	163	192	4.1
Namibia*	824,292											
Niger	1,267,000	1972-73	12			12				10	22	57.6
Nigeria	923,768	1972-73			4	4		41	90	131	135	6.8
Rwanda	26 338	1972-73	2	1	5	8	5	2	2	9	17	1.5
Senegal	196,192	1972-73					5	5	16	26	26	7.5
Sierra Leone*	71,740											
Somalia*	637 657											
Zimbabwe	390,580										(344)	1.1
Sudan	2,505,813	1972-73	3	11	2	21	10	20	132	162	183	13.7
Swaziland*	17,363											
Togo	56,000	1972-73		5		5		25	12	37	42	1.3
Tunisia	163,610	1972-73									(197)	0.8
Uganda	236 036	1972-73	6	1	3	10	9	13	41	63	73	3.2
United Republic of Cameroon	475,422	1972-73	12			12	10	22	37	69	81	5.9
United Republic of Tanzania	945,087	1972-73	24	22	3	49	38	26	61	125	174	5.4
Upper Volta	274,200	1972-73	15	4		19	2	9		11	30	9.1
Western Sahara	266,000	1972-73									0	
Zaire	2,345,409	1972-73								10	10	234
Zambia	752,614	1972-73									(212)	3.6

*Information not received

TABLE 3 - INSTITUTIONALIZED CO-OPERATION IN INTERNATIONAL RIVER AND LAKE BASINS

Region and basin	Name of institution - member countries - headquarters	Year of agreement	Type of institution	Field of co-operation
(1)	(2)	(3)	(4)	(5)
Africa				
Chad	Chad Basin Commission/Commission du bassin du Tchad - Cameroon, Chad, Niger, Nigeria - Ndjamena (Chad)	1964	A	I
Gambia	Gambia River Basin Co-ordinating Committee - Gambia, Senegal	1976	C	I
Kagera	Inter-state Organization for the Development of Kagera River Basin - Burundi, Rwanda, United Rep.of Tanzania	1971	C	I
Mano	Mano River Union - Liberia, Sierra Leone	1976	B	I
Niger	River Niger Commission/Commission du Fleuve Niger - Benin, United Rep. of Cameroon, Chad, Guinea, Ivory Coast, Mali, Niger, Nigeria, Upper Volta - Niamey (Niger)	1963 1964	A	I
Niger (Upper)	Technical Committee for Flood Forecasting and Warning System - Guinea, Mali	1969	C	H
Nile (Lower)	Permanent Joint Technical Commission for Nile Waters - Egypt, Sudan - Khartoum (Sudan)	1959	B	I
Nile (Upper)	Technical Committee for the Hydrometeorological Survey of Lakes Victoria, Kyoga and Mobutu Sese Seko - Burundi, Egypt, Kenya, Rwanda, Sudan, United Rep. of Tanzania, Uganda	1967	B	H
Senegal	Organisation pour la mise en valeur du fleuve du Sénégal (OMVS) - Mali, Mauritania, Senegal - Dakar (Senegal)	1968	A	I
Tanganyika	Inter-State Technical Committee for the Development of the Water Resources of Lake Tanganyika Basin - Burundi, Rwanda, United Rep. of Tanzania, Zambia, Zaire - Bujumbura (Burundi)	1975	B	I

(i) Historical records of past floods;

(ii) Records of precipitation and surface-water discharge in rivers;

(iii) Geomorphological studies based on ground surveys or on aerial photographs.

In the main river valleys, for which such data are generally available, the task of compiling flood-zoning maps is relatively easy. It is far more difficult in arid and semi-arid areas, where flash-floods may occur in small valleys with little or no stream flow in normal circumstances and for which meteorological or hydrological data may be completely lacking. However, in areas for which sufficient data are available, flood-zoning maps are of vital importance in land-use planning and can be a major factor in reducing risks.

In large river valleys, in which adequate networks of rain-gauges and hydrometric stations exist, it is sometimes possible to forecast the occurrence of floods and the progress of the flood peaks downstream with sufficient accuracy and sufficiently in advance for effective temporary measures to be taken to protect lives and property threatened by the floods. Established methods exist for forecasting based on hydrometeorological data and are applied in many African countries. Tables 1 and 2, reproduced from WMO Publication No. 464 (Statistical Information on Activities in Operational Hydrology), show the number of precipitation and river-discharge gauges operated in African countries, according to the information available.

Regional co-operation between neighboring countries is highly desirable in the case of major rivers which cross or border on several countries, so that information and data on river discharge, and eventual flood warnings, can be transmitted in due time from one country to another. In Africa, such regional co-operation already exists, regional institutions having been established for the main river basins; these are listed in Table 3, reproduced from WMO Publication No. 464.

3.7 Earthquakes

The assessment of seismic hazard, by which is meant the probabilities of occurrence of seismic ground motion of various intensities at a given site during a given period of time, involves the collection and analysis of data of various kinds and from various sources, including:

(i) instrumental determinations of the epicentral co-ordinates and magnitudes of earthquakes affecting the site in question;

(ii) historical information on earthquakes which occurred before the installation of seismological instruments (i.e. in general, before 1900 A.D.);

(iii) geological evidence of faulting and vertical movements which, when correlated with seismological data, makes it possible to identify the zones in which earthquakes are likely to occur;

(iv) data on the attenuation of seismic waves between these seismic source zones and the site in question;

(v) geotechnical data on the dynamical properties of the soil and subsoil at the site; and

(vi) if possible, recordings of actual seismic ground motion at or near the site.

For the purposes of physical planning, seismic hazard can usefully be expressed in the form of maps showing maximum seismic intensities to be expected, at a given level of probability, in all parts of the area under study. For the purposes of engineering design, seismic intensity should preferably be expressed in terms of one or more physical parameters (e.g. peak ground acceleration, peak particle velocity, etc.) that can be used directly to calculate the response of various types of structures. Seismic hazard at a given site can also be expressed in the form of probability distribution (or exceedance) curves of various seismic intensities at the site.

Table 4 shows a list of the seismological stations in operation in Africa in 1982 and whose data are communicated to the International Seismological Centre. While Djibouti and Morocco have seismological networks of adequate density, and the network in Algeria is at present being improved under the PNUD/RAR programme, the networks in other countries in the seismic zones of Africa are still not of sufficient density to provide the data needed for accurate hazard assessment.

In the countries of North Africa, research into historical sources, mainly Arabic, has brought to light a considerable volume of useful information on past earthquakes. Similar work has been carried out in Ethiopia, but in most other African countries such historical information is very scanty.

Geological studies leading to the preparation of seismotectonic maps have been carried out in North and in East Africa.

A detailed study of local soil conditions has been undertaken in Ech Chlef (Algeria) but, as far as is known, no other such systematic study has been attempted elsewhere in Africa.

As far as is known, no recording of strong ground motion due to an earthquake has yet been obtained in Africa. There is an urgent need for more strong-motion accelerographs, since only they can provide the data needed for earthquake-resistant design and construction.

SEISMOLOGICAL OBSERVATORIES
in order of geographical zone

AFRICA

ALGERIA
- ABA Alger-Bouzareah
- ALG Algiers Univ
- BAB Beni-Abbès
- IAA C In Amguel
- OFD Oued Foida
- REL C Relizane
- RLA Relizane
- SET Sétif
- TAM Tamanrasset
- TEC Tlemcen

ANGOLA
- DUN Dundo
- LUA C Luanda
- SDB Sá da Bandeira

CAMEROUN
- NGC Ngoundere
- YND Yaounde

CENTRAL AFRICAN REPUBLIC
- BCAC Bangui
- BNG Bangui

CHAD
- ABC C Abéché

DJIBOUTI
- ARO Arta Oba
- ART C Arta
- ATA Atar
- DAF Dafaré
- GBR Grand-Bara
- HLD Halaksitan
- KSV Kousscur
- MKL Maskali
- OBO Obock
- SGH Sud-Ghoubbet
- TDD Ara
- TDJ C Tadjoura

EGYPT
- ASL Abu Simbel
- ASW Aswan
- HLW Helwan
- MMT Marsa Matruh

EQUATORIAL GUINEA
FERNANDO PÓO
- MFP Moca

ETHIOPIA
- AAE Addis Ababa

GHANA
- KUK Kukurantumi

IVORY COAST
- KIC Kosan Boka
- LIC Lamto
- TIC Toumodi

KENYA
- NAI Nairobi
- NAKC Nairobi

MALAWI
- CLK Chileka

MOROCCO
- AIT Ait Ouarda
- AVE Averroes
- BMT Barrage Battouta
- BMB Ben Abdellah
- BME Barrage Eddahbi
- BMK El Makhazine
- HAD Hassan Addkhil
- IDR Idriss 1er
- IFR Ifrane
- KES C Ksar Es Souk
- NKM Nakhla
- RBA Rabat
- RBZ Rabat Zaers
- TAF Taforait
- TIO Tiouine
- YBT Youssef Tachfine

MOZAMBIQUE
- CNG Changalane
- LMM Lourenço Marques
- NPA Nampula
- TET Tete

NIGERIA
- ZAR C Zaria

RWANDA
- BTR C Butare

SENEGAL
- BKL Bakel
- DAK C Dakar
- KDG Kedougou
- KDS Kedougou
- KED C Kedougou
- MBO M'Bour
- MMS C Matam

SOMALIA
- MOG C Mogadiscio

NAMIBIA		
WIN		Windhoek
SUDAN		
NYA		Nyala
SWAZILAND		
SWD		Swaziland
TANZANIA		
DOD	C	Dodoma
TOGO		
LOM		Lomé
TUNISIA		
GAF		Gafsa
KCHT		Kechabta
MBZ		Menzel Bou-zelfa
SBS		Sidi-Bou-Said
THA		Thala
TUN	C	Tunis
ZGN		Zaghouan
UGANDA		
ENT	C	Entebbe
ZAIRE		
BIN		Binsa
BTC		Butembo
DCC		Delcommune
ELI	C	Elizabethville
GUB		Guba
LBC		Lubudi
LMA		Le Marinel
LWI		Lwiro
MLN		Mulungwishi
RUM		Rumangabo
UVI	C	Uvira
ZAMBIA		
BHA		Broken Hill
LUS		Lusaka
ZIMBABWE		
BUL		Bulawayo
CIR		Chiredzi
KRB	C	Kariba Dam
KRI		Karoi
KRR	C	Karoi
MTD		Mount Darwin

Note

C = Closed

Hopes have been raised in recent years that, with sufficient observational data, it may become possible to predict, with a useful degree of accuracy, the time and place of potential damaging earthquakes. Although there have been a few notable successes, no reliable method of prediction has yet been developed; and it seems unlikely that any widely applicable technique of earthquake prediction will become available in the foreseeable future.

3.4 Volcanic eruptions

The immense destructive power of volcanic phenomena such as lava flows, lahars and heavy ash falls, makes it imperative to locate and map the zones around each active or dormant volcano which are exposed to any of these phenomena in the event of an eruption.

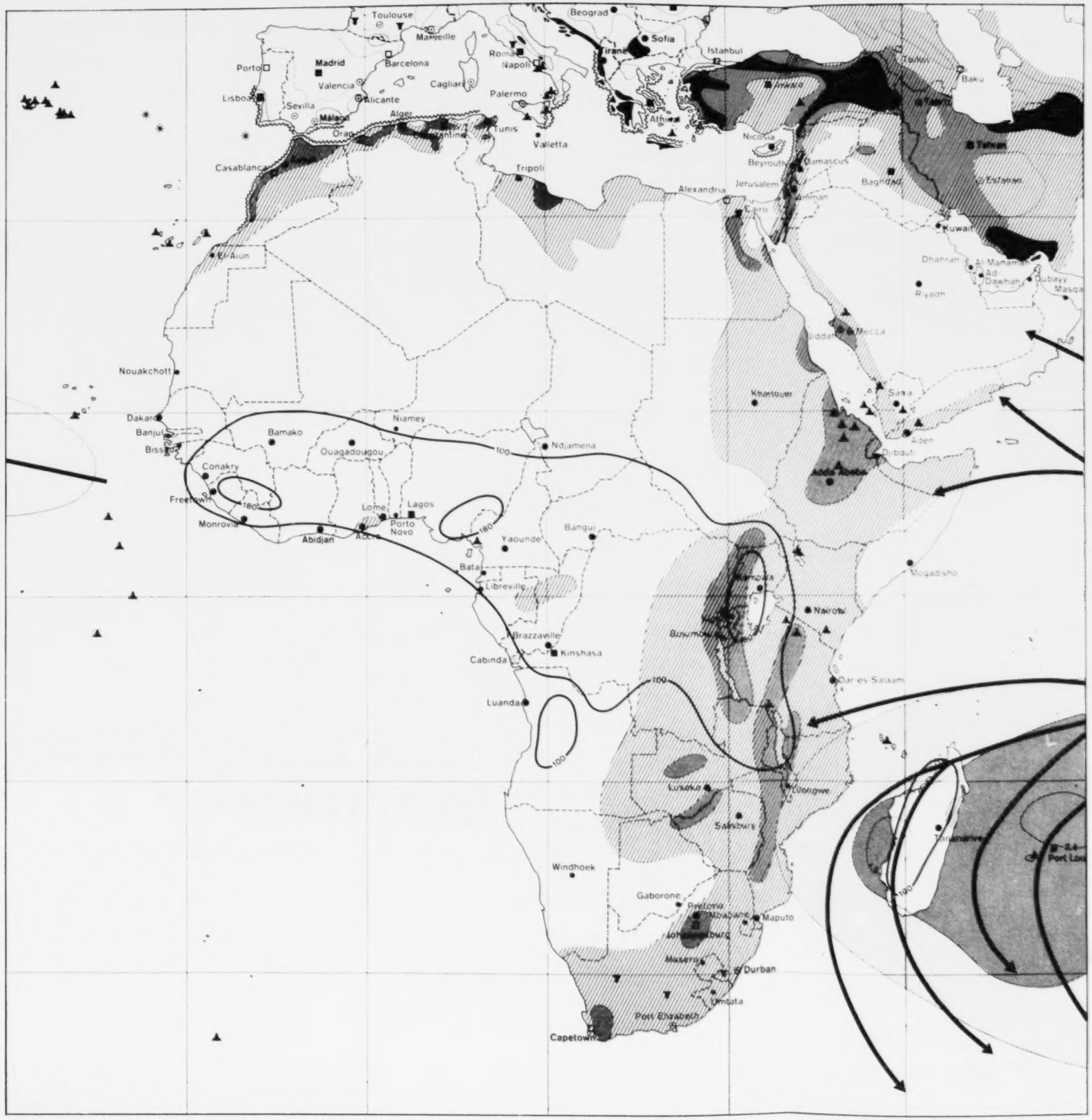
The methodology of volcanic-hazard zoning is by now well developed (UNESCO, in press) and the investment needed in terms of scientific manpower and equipment is not beyond the resources of the African countries concerned.

Volcanic-hazard zoning maps can be used in land-use planning, since they make it possible to identify the areas which, though too dangerous for permanent settlement, can nevertheless be exploited for agricultural purposes (volcanic soils are usually highly productive).

As far as is known, no hazard zoning map has yet been prepared for any African volcano.

Whenever an active or dormant volcano is known to exist in or near a populated area, it is obviously desirable that some warning should be obtained of impending eruptions, so that people can be evacuated in good time from any areas likely to be affected by one or other of the violent phenomena mentioned above. Modern methods of volcanic surveillance and monitoring (by means of seismometers, tiltmeters, distance measurements, magnetometers, chemical sensors, etc.) offer the possibility of predicting with some degree of certainty the onset of eruptions and their more violent manifestations. However, no such monitoring system has yet been installed on any African volcano, except for Piton de la Fournaise (Réunion).

Map of natural hazards in Africa



SEISMIC RISK

Maximum intensity (Mercalli Scale) once in 50 years, for average ground conditions

- VI and VII
- VIII
- IX
- * epicentres of magnitude 8 earthquakes (1897 - 1977)

WINDSTORM RISK

Tropical storms and cyclones (Beaufort 8 and above)

- 0.1 – 1
- 1 – 3
- —1.8— Isoline of maximum frequency
- Preferred tracks

TORNADOES

- 1 per year

OTHER NATURAL HAZARDS

- Tsunamis (seismic sea wave)
- Active volcanoes
- —100— Isoline of thunderstorm days, number per year.

Reproduced with kind permission of Münchener Rückversicherungs Gesellschaft, West Germany, from *World Map of Natural Hazards Munich Re, 1978.* (The boundaries and names on this map do not imply official endorsement or acceptance by the United Nations).

4. PREVENTIVE MEASURES

In general, there are two ways of reducing the risk of natural disasters. The first is to locate new settlements and development projects as far as possible in zones of lower hazard; this can be done if accurate hazard maps are available. The second is to ensure, by means of appropriate building codes (and their enforcement) that all new constructions are designed and built to resist the forces likely to be exerted on them by wind, earthquake, flood, etc.

4.1 Tropical cyclones

The general principles of building design and construction to resist strong winds are by now well known. Simple methods of strengthening old or non-engineered traditional buildings, particularly their roofing, are also widely known. In many countries the normal building codes require that wind loading be taken into account in the design of buildings, taking into account the maximum wind speed likely to occur in each area. However, the extent of the damage caused by tropical cyclones in many countries indicates that these methods and techniques are not by any means universally applied in practice. There is certainly a need for further efforts to make the appropriate techniques more widely known and understood.

Preventive measures against the secondary effects of tropical cyclones (i.e. floods and storm surges) are discussed in the following section.

4.2 Floods

The general principles of flood control in any river basin, large or small, may be summarized as follows:

A. In the catchment area and upper reaches of the river

(i) promote the infiltration of rainwater into the soil, in order to reduce the surface run-off;

(ii) retain surface waters in the catchment area and retard the flow downstream.

B. In the lower reaches of the river

(i) promote rapid discharge by removing obstacles to river flow;

(ii) raise and strengthen river banks to prevent overtopping.

The main factor determining the ratio between infiltration and surface run-off in the catchment area, particularly in mountainous regions, is the nature and density of the vegetation cover. Deforestation promotes run-off

and flooding; afforestation and other appropriate agricultural practices such as contour ploughing, favour infiltration and thus reduce the risk of flooding.

In the upper reaches of rivers, the risk of flash-flooding can be reduced significantly by terracing on steep slopes and by the construction of small retention dams and barriers in watercourses. These retard run-off and reduce flood peaks in the lower reaches.

Many of the larger rivers in Africa have already been the subject of major engineering works aimed at controlling floods. The large dams built on the Niger (at Kainji), the Nile (at Aswan), the Volta (at Akosombo) and the Zambezi (at Kariba) serve not only for flood control but also for power generation and to provide water for irrigation. Many smaller rivers in Africa have also been dammed and their flood plains protected by dikes and levees. The very considerable investments needed for such major engineering works are fully justified by the economic benefits they bring.

Except in Mozambique, there are few low-lying coastal plains in those parts of Africa exposed to storm surges generated by the tropical cyclones of the southwest Indian Ocean, and there has been no disaster in Africa comparable with those that have occurred on the coasts of India and Bangladesh facing the Bay of Bengal. Important settlements or development projects in some coastal areas of Mozambique should nevertheless be protected, by dikes and levees, from storm surges which may occur in these areas.

4.3 Earthquakes

If all buildings in all seismic zones were designed and constructed to resist earthquake forces, earthquakes would no longer present any risk to life and property.

The general principles of earthquake-resistant design and construction are well known, though research is still needed into the details or design of particular structures and into soil-structure interaction. Furthermore, earthquake-resistant design can be effective only if the parameters of the probable seismic ground motions are accurately known, which is not always, or even often, the case at the present time.

In many countries throughout the world, special codes and regulations governing the design and construction of buildings in seismic zones have been promulgated and are enforced by the checking of designs and by on-site inspection. There is no doubt that the enforcement of these codes and regulations results in very significant reduction of the seismic risk to new constructions. Techniques also exist for the strengthening of existing

buildings to resist earthquake forces.

Two African countries (Algeria and Morocco) have taken the necessary legislative action to promulgate and enforce anti-seismic building codes. These are both based on the French PS-69 code, which is at present under revision in France.

4.4 Volcanic eruptions

The violence of volcanic phenomena such as glowing avalanches and lahars is such that no normal building subjected to them is likely to escape total destruction. Only underground shelters of the kind designed to resist nuclear attack can offer effective protection against glowing avalanches.

Even the milder manifestations of volcanic activity, such as lava flows, are hardly amenable to control even by major engineering works, though some success has been achieved in Iceland in attempts to retard the advance of viscous lava by spraying it with large quantities of water.

Protection against volcanic eruptions thus consists mainly in restricting settlement and investment in the hazardous zones surrounding each volcano, and in evacuation when eruptions occur.

5. DISASTER PREPAREDNESS

Despite the considerable efforts already being made to provide increased protection against the violent forces of nature, it must still be expected that disastrous cyclones, floods, earthquakes and other such events will continue to occur from time to time.

Disaster preparedness may be defined as action to organize and facilitate timely and effective rescue, relief and rehabilitation in case of disaster. It is concerned with response to forecasts and warnings of phenomena likely to cause disaster and with planning the management of emergency situations. It includes the elaboration of plans for short-term and temporary protective measures, the stockpiling of relief supplies, the training of relief personnel, public education and information and, last but not least, the mobilization of funds for potential relief operations.

The inevitability of the occurrence of certain natural phenomena makes it imperative that countries should plan the emergency procedures to be applied in the event of a natural disaster. By so doing, lives may be saved and property damage reduced.

Much of the confusion which often follows the occurrence of a disaster is caused by the lack of detailed preparedness plans. The episodic nature of disasters, which is difficult to deal with in legal and administrative terms, is in part responsible for the relative low priority accorded to the establishment of such plans. Even in countries where preparedness plans exist, they may often be incomplete or out of date and, therefore, unable to provide a practical guide for effective action.

Disaster preparedness planning will normally start with the promulgation of emergency legislation. This legislation should made provision for the declaration of a state of disaster emergency, the legal consequences of which may be far-reaching: ordinary procedures of government agencies may be suspended; emergency plans are activated; movement of persons may be restricted; troops may be deployed to the stricken area; and private property, supplies, equipment and facilities may have to be requisitioned.

Often, this legislation also determines which government agency will assure operational responsibility for relief and rescue operations. As circumstances vary from country to country, this may be the Minister for the Interior, the Minister for Social Welfare, or a special co-ordinating body under the responsibility of the Prime Minister.

Experience has shown that the multi-disciplinary character of a well-organized and efficient relief operation calls for an institutionalized and permanent co-ordinating mechanism placed directly under the Prime Minister, with a small and permanent secretariat attached to his Office. Further provisions may then be made for delegation of the responsibility to be assumed regionally or locally (Provincial Governors, Mayors, etc.) or functionally (Ministries of the Interior, Health, Public Works, Agriculture, etc.).

From the information available, which is of necessity incomplete, it appears that among the 50 Member States composing the Economic Commission for Africa, about 30 have assigned responsibility for emergency preparedness and relief to a specific government agency, and that in some 15 countries the Governments have promulgated comprehensive emergency legislation and plans.

It has been clearly proved that the costs of disaster preparedness are small in comparison with the losses inflicted by disasters. In general, UNDRO recommends that preparedness plans contain at least the following main elements:

- establishment of forecasting and warning systems;
- establishment and testing of operational emergency plans;
- evacuation plans for populations at risk;
- training of relief workers;
- public education and information;
- stockpiling of supplies for immediate needs
- earmarking of necessary funds;
- assessment of damage and evaluation of relief needs;
- emergency shelter and distribution of relief supplies;
- restoration of essential services.

The precise content of a preparedness plan will depend to a great extent on whether or not some warning can be expected of an impending disaster. The prospects for effective warning of tropical cyclones, floods, earthquakes and volcanic eruptions have been discussed above.

All predictions of natural phenomena are subject to some degree of uncertainty. Furthermore, the effects of these phenomena can be anticipated only if the vulnerability of buildings and structures to their impact is known. Reliable data on vulnerability are scarce; but once they are available, scenarios of possible disasters can be prepared and detailed plans made to deal with each situation as it occurs. Preparation is always preferable to improvisation.

One vital element in all preparedness planning is close liaison between the responsible public authorities and the scientific and technical

institutions responsible for assessing hazards and for forecasting. Another is adequate education and information of the public regarding the nature of the natural hazards, the steps taken by the public authorities to provide protection against them and the action that each person can take to minimize the risk to his life and property.

6. ROLE OF THE UNITED NATIONS AND ITS SPECIALIZED AGENCIES

The United Nations and its Specialized Agencies are actively concerned with disaster mitigation and preparedness in African countries.

The United Nations Centre for Human Settlements (HABITAT) promotes the integration of the concepts of risk assessment, disaster mitigation and preparedness into physical planning and urban design. Under the United Nations Development Programme it has executed two projects in Africa:

(i) The reconstruction of human settlements in the El Asnam (now Ech Chlef) region of Algeria, following the disastrous earthquake of 10 October 1980; and

(ii) The planning and reconstruction of human settlements in disaster-prone areas of Upper Egypt, following the severe flash-floods of October 1979.

HABITAT has made available for general use 15 audio-visual presentations on natural disasters which had been prepared for the United Nations Conference on Human Settlements (Vancouver, 1976) and for the fifth session of the Commission on Human Settlememts (Nairobi, 1982).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) has since 1961 been conducting a programme on the scientific study of natural disasters and of the means of protection against them, directed particularly towards earthquakes, tsunamis, landslides and volcanic eruptions. In 1980 UNESCO held in Nairobi a regional seminar on seismic risks in countries associated with the East African Rift system. At the request of the Arab Fund for Economic and Social Development, it undertook in 1982 a feasibility study of a Programme for the Assessment and Mitigation of Earthquake Risk in the Arab Region (PAMERAR), which includes the Arabic-speaking countries of North Africa (Algeria, Egypt, Libya, Morocco, Sudan and Tunisia). UNESCO has also sent missions of experts, at the request of the governments concerned, to advise on the problems posed by volcanic hazards in Cameroon, flood hazards in Tunisia and by the seismic activity associated with the Aswan High Dam in Egypt.

The United Nations Food and Agriculture Organization (FAO) has only a limited programme directly related to natural hazards other than droughts, but it has carried out, in co-operation with the World Food Programme, several emergency assistance projects after earthquakes, floods and cyclones (Algeria, 1980; Mauritius, 1980 and 1982; Sudan, 1983; Madagascar, 1982; etc.). FAO's Remote Sensing Centre has promoted the use of remote-sensing techniques for

flood monitoring; studies of this kind were made in Algeria and Libya in 1976-77 and in the Sudan in 1978. The FAO Early Warning System also monitors the effects on food supply of natural hazards such as locusts and other plant pests and diseases. Under its Food Security Assistance Scheme, it takes account of the vulnerability of the population to natural disasters in the planning and implementation of programmes to improve national food security.

The United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) have both made significant contributions to disaster mitigation and relief through projects executed by the Specialized Agencies and by individual governments.

The World Health Organization (WHO) has the basic responsibility in emergencies for co-ordinating assistance in the field of public health. The emergency assistance of WHO itself is limited to the provision of technical personnel and of urgently needed supplies and equipment. WHO can command the technical facilities for the rapid on-the-spot assessment of needs for medical supplies, including vaccines. In 1982 alone, WHO provided assistance following floods and subsequent epidemics to a number of African countries: Benin, Chad, Ethiopia, Ghana, Guinea-Bissau, Lesotho, Liberia, Mauritius, Mozambique, Niger, Seychelles, Tanzania, Togo, Uganda and Zaïre. In the field of disaster preparedness WHO provides technical and administrative advice on the establishment of national systems for the rapid assessment of the health situation and needs in disaster-stricken countries: for instance, in Benin, Madagascar, Mozambique and Senegal, preventive measures have averted epidemics after recent flood emergencies.

The World Meteorological Organization (WMO) contributes to disaster prevention and preparedness in Africa through a number of activities. Its global Tropical Cyclone Programme aims at strengthening the capabilities of Member States to detect, track and forecast the approach of tropical cyclones and to organize and execute the essential disaster prevention and preparedness measures. Under this Programme, WMO has set up the Tropical Cyclone Committee for the southwest Indian Ocean, grouping eight African countries (Comoros, France (Réunion), Madagascar, Malawi, Mauritius, Mozambique, the Seychelles and Tanzania). This Committee co-ordinates activities with respect to cyclone warning in the subregion. At the same time, WMO has provided technical assistance to African countries in hydrometeorological surveys and in hydrological forecasting in the major river basins of the Niger and the Nile.

Finally, the Office of the United Nations Disaster Relief Co-ordinator (UNDRO) is active in mobilizing and co-ordinating international emergency

assistance to disaster-affected countries at the request of their governments. For example, in 1982 international assistance was mobilized through UNDRO for Benin, Chad, Comoros, Mozambique, Tunisia and others. At the same time, UNDRO provides technical assistance in disaster prevention and pre-disaster planning, aimed at strengthening the governments' abilities to mitigate the effects of natural disasters and to improve the organization of disaster relief operations. Lately, such assistance has been provided to Madagascar, Mozambique, Senegal, Somalia and Tanzania. In 1980-82 UNDRO co-operated with HABITAT in the execution of a project in flood prevention and reconstruction for a number of rural communities in Upper Egypt.

In co-operation with WMO and the League of Red Cross Societies, UNDRO has contributed to the improvement of disaster prevention and preparedness in cyclone-prone countries in Africa, through the Tropical Cyclone Committee for the southwest Indian Ocean. A subregional training course in disaster prevention and preparedness is in preparation.

7. STRATEGY AND RECOMMENDATIONS

In 1980, by its resolution 35/36, the United Nations General Assembly adopted an International Development Strategy for the Third United Nations Development Decade. The Strategy itself is set out in the Annex to the resolution and includes special provisions in favour of least developed countries, most seriously affected countries, land-locked developing countries and developing island countries - in all of which categories one or more Member States of the Economic Commission for Africa are to be found. So far as disasters are concerned, the Strategy contains the following paragraph:

> "Recognizing the detrimental effects of disasters on the development of developing countries, the international community will take measures to improve and strengthen arrangements to provide developing countries with adequate and timely assistance in matters of disaster relief, prevention and preparedness."

The latest resolutions on the implementation of the Strategy are to be found in the records of the 37th General Assembly (1982). They are "Action programme in favour of island developing countries" (37/206), and "Implementation of the Substantial New Programme of Action for the 1980's for the Least Developed Countries" (37/224).

More specific resolutions affecting Africa, its regions, subregions and individual countries, and relevant to the subject of disasters and development, relate to the consequences of drought and desertification and to post-disaster humanitarian assistance.

In the preceding sections of this paper, mention has been made of many activities undertaken by the United Nations and its Specialized Agencies in response to, or in accordance with, the above resolutions. It is recommended that they continue to support national and regional efforts to mitigate the losses from natural disasters, and in particular that they should:

a) offer technical assistance at the request of interested governments to review the hazard assessment practice and the adequacy of existing networks of observational facilities for monitoring disastrous natural phenomena, with a view to forecasting and timely warning on imminent disasters;

b) help in making assessments of natural hazards and in quantitative evaluation of risks wherever needed;

c) provide technical assistance in the improvement of disaster forecasting techniques and in other aspects of disaster preparedness, including strengthening existing or creating new national disaster

preparedness organizations and making available the use of advanced techniques, such as remote sensing, etc.;

d) provide technical and other assistance in planning and implementing flood control and flood-protection works;

e) promote or undertake regional or subregional studies related to disastrous natural phenomena, in consultation with the countries concerned, with a view to enhancing their ability to forecast disasters and to mitigate their effects;

f) strengthen and expand the existing training institutions and facilities for professional personnel dealing with disaster management, provide scholarships and organize training seminars on various aspects of disaster prevention and preparedness.

g) promote the integration of natural hazard and risk assessment into physical planning and urban design, and offer technical assistance in drafting building codes and regulations aimed at reducing the vulnerability of buildings and public works to the forces exerted on them by strong winds and earthquakes.

Regional Co-operation

It is recommended that the African countries:

a) review existing arrangements for regional and subregional co-operation in various fields related to disastrous natural phenomena and co-operate in the establishment of programmes, machinery and institutions necessary for the co-ordinated development of hazard assessment, disaster prevention and preparedness, including monitoring natural phenomena with a view to forecasting and timely warning;

b) encourage exchange of information on natural phenomena between African countries on a bilateral and multilateral basis, using regional and subregional institutions;

c) give full support to existing regional and subregional bodies such as the river and lake basin Commissions, the Tropical Cyclone Committee for the Southwest Indian Ocean, and make full use of the machinery provided by these bodies for co-operation and information exchange;

d) examine the need and possibilities for establishing additional intergovernmental institutions for regional or subregional co-operation in the field of disaster prevention and preparedness and create them wherever needed; and

e) encourage joint education and training schemes for professional and subprofessional personnel in subjects related to natural hazards,

such as hydrology, tropical meteorology and geophysics as well as in the field of disaster management.

In addition to the above action at the international and regional level, it is recommended that all African countries in disaster-prone areas take the following action at the national level:

A. Hazard assessment

(i) establish or strengthen institutions responsible for the study and monitoring of potentially disastrous natural phenomena and for hazard assessment and mapping;

(ii) extend and improve the networks of observing stations, including those concerned with the monitoring of tropical storms, river discharge, earthquakes and volcanoes;

(iii) promote and assist the preparation of hazard maps on scales suitable for use in physical and urban planning and in economic analysis;

(iv) promote and assist the preparation of hazard maps and assessments in forms suitable for use in the design of wind-resistant and earthquake-resistant buildings and structures; and

(v) create appropriate mechanisms for close liaison between the institutions responsible for hazard assessment and the public authorities responsible for disaster prevention and preparedness.

B. Disaster prevention

(i) promote the integration of risk-management concepts into the planning of new settlements and development projects;

(ii) promulgate and enforce building codes and regulations for wind-resistant and earthquake-resistant design and construction in zones exposed to these hazards;

(iii) encourage afforestation and other measures to protect the vegetation cover in catchment areas of rivers, with a view to reducing the surface run-off; and

(iv) give high priority to engineering works for flood control.

C. Disaster preparedness

(i) establish or strengthen national disaster preparedness organizations and enact the legislation necessary to enable them to fulfil their role effectively in case of disaster;

(ii) prepare scenarios of possible disasters, taking into account the known hazards and the vulnerability of buildings and other structures to these hazards;

(iii) elaborate and test operational emergency plans;

(iv) allocate necessary emergency funds and establish stockpiles of supplies for immediate needs;

(v) establish machinery for applying for international emergency assistance facilitating the delivery of international aid in case of need; and

(vi) train disaster management personnel.

D. Public education and information

(i) take all appropriate measures to ensure that the general public understands the nature of the risks and the reasons behind the steps taken by the public authorities to reduce these risks;

(ii) prepare simple documentary for use in schools to explain the nature of the hazards and the means of protection against them;

(iii) initiate appropriate public information campaigns, using the mass media; and

(iv) include disaster-awareness programmes in preparedness planning.

BIBLIOGRAPHY

Asian Regional Institute for School Building Research: Typhoon - Construction of typhoon-resistant buildings. Colombo, 1972.

Fairhead, J. D. and Girdler, R. W.: The seismicity of Africa. Geophys. Jour., R. Astr. Soc., 24, pp. 271-301, 1971.

Gouin, P. (1979): Earthquake history of Ethiopia and the Horn of Africa. International Development Research Center, Ottawa.

International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI): Catalogue of the Active Volcanoes of the World, Part IV, Africa and the Red Sea, 1957.

International Seismological Centre, Newbury, U. K.: Regional catalogue of earthquakes: semi-annual publication.

Loupekine, I. S. (1971): A catalogue of felt earthquakes in Kenya, 1892-1969. Seismology Unit, Geology Dept., University of Nairobi, Kenya.

Munich Reinsurance Co. (1978): World map of natural hazards.

Smithsonian Institution: Scientific Event Alert Network Bulletin, Vol. 7-1, January 1982.

Tazieff, H.: An exceptional eruption: Mt. Niragongo, January 10, 1977. Bulletin Volcanologique, Vol. 40-3, 1976-77.

UNESCO: International Tectonic Map of Africa, 1968.

- Annual Summary of Information on Natural Disaster, Vols. 1 - 10, 1966-1975.
- Programme for the assessment and mitigation of earthquake risk in the Arab region, 1983.

UNESCO Regional Office for Education in Asia (1973): Small buildings in earthquake areas.

UNESCO Regional Office for Science and Technology for Africa (1980): Regional seminar on seismic risks in countries associated with the East African Rift System: report and summary of recommendations.

United Nations Centre for Human Settlements (UNCHS - HABITAT) 1983: Planning for human settlements in disaster-prone areas.

United Nations Disaster Relief Co-ordinator (UNDRO): Disaster prevention and mitigation - UNDRO/UNEP compendium of current knowledge, Vols. 1 - 12.

- Guidelines for disaster prevention, Vols. 1 - 3.
- Natural disasters and vulnerability analysis: report of expert group.
- Mobile disaster units: final report of international meeting, 1982.
- Shelter after disaster: guidelines for assistance, 1982.
- Disasters and the disabled, 1982.
- Space applications for the acquisition and dissemination of disaster-related data: final report of expert meeting, 1983.
- Mission reports: Floods, Egypt, 1975.
  Cyclone, Madagascar, 1977.
  Floods, Mozambique, 1977.
  Cyclone, Madagascar, 1978.
  Floods, Sudan, 1975.

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP): Principes directeurs pour la prévention des catastrophes et les précautions à prendre à cet égard dans les zones exposées aux cyclones tropicaux. Report published jointly with WMO and LICROSS, Geneva/Bangkok, 1977.

United Nations Educational, Scientific and Cultural Organization (UNESCO):
- Développement des recherches volcanologiques au Cameroun, 1969.
- Les inondations de septembre-octobre 1969 en Tunisie.

United States National Geophysical and Solar-Terrestrial Data Center: Significant earthquakes, 1900-1979 (world map).

U. S. Office of Foreign Disaster Assistance (OFDA): Disaster history - Significant data on major disasters world-wide, Washington, D. C., March 1983.

USSR Academy of Sciences (1968): Preliminary report of the Soviet East African expedition.

World Meteorological Organization (WMO): The quantitative evaluation of the risk of disaster from tropical cyclones. Special Environmental Report No. 8, WMO Publication No. 455, 1976.

- RA I Tropical Cyclone Committee for the Southwest Indian Ocean: Final report of the Fifth Session, Mahe, Seychelles, September 1981.
- Statistical information on activities in operational hydrology. WMO Publication No. 464, 1977.

ANNEX

DATA ON HUMAN AND ECONOMIC LOSSES FROM NATURAL DISASTERS IN AFRICA

(floods, storms, earthquakes and volcanic eruptions)

COUNTRY	REGION	DATE	TYPE OF DISASTER	NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
Algeria	Kabylia	24 June 1910	earthquake	12				
	(Constantine)	12 Feb. 1946	earthquake	276				
	(Orleansville)	9 Sep. 1954	earthquake	1,243				(6,000,000)
	El Asnam							25,850 houses destroyed
	M'Sila	21 Feb. 1960	earthquake	57				250 houses destroyed
	Southern	Dec. 1963	floods			45,400	45,400	
	M'Sila	1 Jan. 1965	earthquake	2	350	37,000	37,000	2,000,000
	West El Asnam	6 Oct. 1966	floods	57	12	15,900	20,000	10,000,000
	Aurès Samura	Nov. 1967	floods	20		30,000	30,000	3,000,000
	Constantine Eastern	28 Sep. 1969	floods	76	237			10,000,000
	Northeast	Mar. 1973	floods	21		61,000	85,000	10,000,000
	Tlemcen							40,000 hectares cultivation damaged; 37,000 hectares crops lost
	Kabylia, Tlemcen	31 Mar. 1974	floods	11			20,000	30,000,000
	Western	Dec. 1979	floods				30,000	
	El Asnam	10 Oct. 1980	earthquake	2,633	8,369	443,000	478,948	5,200,000,000
	El Elma	4 Sep. 1981	floods	43	50			
	Annaba	10 Nov. 1982	floods	37	14		8,500	
			Since 1900:	4,488	9,032	632,300	754,848	5,271,000,000
Benin	Atacora	Sep. 1970	floods					200,000
	3 coastal provinces	3 June 1982	floods			80,000	500,000	
						80,000	500,000	200,000

COUNTRY	REGION	DATE	TYPE OF DISASTER
Botswana	Tati and Ntse Rivers	19 Jan. 1972	floods
Cape Verde		29 Sep. 1982	hurricane
Central African Rep.	Bangui	12 Sep. 1973	floods
	Bimbo	18 Nov. 1981	storm
Chad	Moundan	20 May 1977	storm
Comoros		4 Jan. 1951	storm
	Grande Comore	4 Apr. 1977	volcanic eru Karthala
	3 islands	10 Jan. 1983	cyclone
Congo	Kivu province	Aug. 1967	landslide
Djibouti	Djibouti City	Oct. 1977	floods
	Djibouti City	Feb. 1978	floods
	Djibouti City	18 Mar. 1981	floods
Egypt	Fayum	7 Aug. 1847	earthquake
	Northern Egypt	12 Oct. 1856	earthquake
	Lower Egypt	26 June 1926	earthquake
	Nile delta	12 Sep. 1955	earthquake
	Nile River valley	20 Feb. 1975	floods

	NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
				1,000	50,000
	3	122	2,100	2,100	
				13,000	
		50	900	900	
		50	900	13,900	
	13	100			
	500				
tion	1		5,000	20,000	
	40			30,000	8,800,000
	541		5,000	50,000	8,800,000
	154		168	500	
			6,000	85,000	2,500,000
					10,000 buildings damaged;
			6,000	100,000	15,000 buildings damaged
	25			102,000	
	25		12,000	287,000	2,500,000
	85	62			3,000 houses destroyed
	10				
	12				
	18				
	15				

COUNTRY	REGION	DATE	TYPE OF DISASTER
Egypt (cont'd.)		6 May 1979	storm, rains and sandstorms
	Upper Egypt	18 Oct. 1979	floods
			Since 1900:
Ethiopia	Shoa	25 Aug. 1906	earthquake
	Wollo	1-2 June 1961	earthquake
	Kelafo	7 May 1968	floods
	NE at Serdo	29 Mar. 1969	earthquake
	Gode Kelafo Mustahil	Apr. 1976	floods
	Awash River Valley	Nov. 1977	floods
		Aug. 1978	floods
	Kelafo	1981	floods
Ghana	Central, south along coast	July 1968	floods
Kenya	Nyanza and western provinces	May 1964	floods
	Nyanza and western provinces	May 1968	floods
		1975	floods
	Widespread	May 1977	floods
	Near Lake Victoria	Oct. 1982	floods
Liberia	Near Mano River	6 Oct. 1982	landslide

NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
3		15,000	15,000	
50			66,000	14,000,000
98		15,000	81,000	14,000,000
unknown				heavy, M = 6 3/4 Majete destroyed
1		6,000	10,000	920,000
45	163	420		320,000
		20,000	50,000	
7			16,000	1,876 hectares crops lost
9			1,000	
			20,000	
62	163	26,420	97,000	1,240,000
		25,000	25,000	14,700,000
		15,000	15,000	
				50,000
			16,000	
100			20,000	10,000,000
75		3,000	3,000	
175		18,000	54,000	10,050,000
46			200	

COUNTRY	REGION	DATE	TYPE OF DISASTER
Libya	El Marj	Mar. 1963	earthquake
Madagascar	NE Andapa SW Tulear	Jan. 1968	cyclone
	East to West Nosy Varika	5 Feb. 1969	cyclone
	Central and South	23 Feb. 1970	cyclone
	Central	14 Feb. 1972	cyclone
	North	10 Jan. 1975	3 cyclones
	Tamatave	8 Mar. 1975	cyclone
	Northwest	Jan. 1976	2 cyclones
	5 provinces	1 Feb. 1977	cyclone
	Tulear	28 Dec. 1978	cyclone
	Countrywide	11 Jan. 1982	flood, heavy ra cyclones
Malawi	South along Ruo River	Mar. 1967	floods
	Shire River Valley	Jan. 1969	floods
	Lake Malawi Shores	May 1979	floods
Mauritius	Rodrigues Island	25 Dec. 1967	cyclone
	Rodrigues Island	1 Apr. 1968	cyclone
	Rodrigues Island	17 Feb. 1972	cyclone
	Entire Islands	6 Feb. 1975	cyclone

NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
320				5,000,000 1,000 houses destroyed
29		10,000	65,000	3,100,000
81			10,000	5,000,000
70			10,000	11,400,000
91	56	10,000	2,500,000	12,420,000
16	26	8,850	500,000	17,000,000
7	50	10,000	10,000	
4	10	100,000	380,000	
10		30,000	30,000	350,000 150,000 hectares rice fields flooded
70		18,000	18,000	14,000,000
107	___	50,000	118,000	250,000,000
485	142	236,850	3,641,000	313,270,000
		1,200	1,200	500,000
		2,300	2,300	200,000
		20,000	20,000	___
		23,500	23,500	700,000
	24	3,500	20,000	5,000,000
2	16		25,000	
9	59		826,199	200,000,000 25% sugar plantations destroyed; 7,662 houses damaged

ns/

COUNTRY	REGION	DATE	TYPE OF DISASTER
Mauritius (cont'd.)	Rodrigues Island	Feb. 1979	cyclone
	Southwest	22 Dec. 1979	cyclone
	Rodrigues Island	13 Jan. 1982	cyclone
Morocco	Tetouan	21 Jan. 1909	earthquake
	Agadir	29 Feb. 1960	earthquake
	Tangier, Gharb	Dec. 1963	floods
	South along Sous and Ziz Rivers	Nov. 1965	floods
	Northern	Jan. 1970	floods
	Western	21 Apr. 1975	floods
	Kenitra, Tetsuan	Jan. 1977	floods
	Fez	Apr. 1982	cliff collapse
			Since 1900:
Mozambique	Umbeluzi River	3 Jan. 1966	floods
	Lourenço Marques and Gaza	Feb. 1967	floods
	Zambezia	29 Jan. 1971	floods
	Limpopo River	Feb. 1975	floods
	Limpopo River	Feb. 1977	floods
	Maputo	22 Oct. 1977	storm, hailstor
	Zambezi Valley	Mar. 1978	floods
	Nampula	23 Dec. 1978	cyclone
Niger	Central	May 1974	floods

NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
5	257	5,000	100,000	175,000,000
—	—	—	32,000	650,000
16	356	8,500	1,003,199	380,650,000
100				
12,000	25,000			120,000,000
69	10	35,000	35,000	
		47,813	47,813	5,000,000
11	3		266,441	30,000,000
10			12,000	
		38,000		
1	—	2,216	10,000	—
12,191	25,013	123,029	371,254	155,000,000
		50,000	50,000	180,000
500			500,000	
1			75,000	crop losses
300		40,000	400,000	55,500,000
3	51			
40		200,000	200,000	63,000,000
				61,500 hectares crops lost; 163 buildings; 72,000 dwellings destroyed
4	—	25,000	80,000	—
848	51	315,000	1,305,000	118,680,000
			16,000	1,000,000

COUNTRY	REGION	DATE	TYPE OF DISASTER
Nigeria	Ibadan	12 Mar. 1978	storm
Réunion	La Fournaise	8 Apr. 1977	volcanic erup
		27 Jan. 1980	cyclone
Rwanda	throughout	June 1974	floods
Senegal	Saint Louis	20 Feb. 1966	storm, tidal
Sierra Leone	Coast	21 Jan. 1975	storm
Somalia	Shabelle, Juba Rivers	Nov. 1977	floods
	Hitan, Juba	Mar. 1981	flash-floods
Sudan	Berber	6 Aug. 1860	earthquake
	Djabel Dumbier	9 Oct. 1966	earthquake
	Central, east	Sep. 1975	floods
	Gash River Gezira Province	Jul. 1978	floods

	NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
	100				
on				1,000	
	25		7,000	7,000	
	25		7,000	8,000	
				1,900,000	loss of 56% staple food crops
ave			2,000	2,000	50,000
	1		?,000	10,000	3,600,000
				40,000	
				20,000	
				60,000	
	1			145,000	
	34			100,000	25,000,000
	35			245,000	25,000,000

COUNTRY	REGION	DATE	TYPE OF DISASTER
Tanzania	Northern	7 May 1964	earthquake
	Pangani River Basin	May 1964	floods
	Rufiji River Valley	Mar. 1968	floods
	Ulanga District	May 1974	floods
	Central, southern	Mar. 1978	floods
	9 regions	June 1979	floods
	Mbeya	4 June 1982	floods
Togo	Sokode, Lama, Kara	Mar. 1966	storm/tornado
Tunisia	Western	1757	earthquake
	Djemod	6 Jan. 1887	earthquake
	Southwest	20 Feb. 1957	earthquake
	Kairoun and Khledi	30 Oct. 1964	floods
	Zarzis	31 Dec. 1964	floods
	Countrywide	24 Sep. 1969	floods
	Medjerda River Valley	21 Mar. 1963	floods
	Central plains, East	Dec. 1973	floods
	Stax, Coastal Areas	30 Oct. 1982	floods
			Since 1900:
Uganda	West, Bwamba County	20 Mar. 1966	earthquake
Zaïre	North Kivu Province, Beni	20 Mar. 1966	earthquake

NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
4		500	500	
		3,900	10,000	
40		57,000	57,000	1,000,000
25		18,000	50,000	3,000,000
			9,000	
			90,000	Worst hit, Mbeya, had never had such a disaster before in living memory.
—		—	40,000	—
69		79,400	256,500	4,000,000
	15			200,000
3,000				
7				
13				
44		5,000	5,000	3,000,000
5		16,000	16,000	
540			271,269	100,000,000
52		41,000	41,000	5,000,000
59		3,240	3,240	
117		—	35,000	8,000,000
830		65,240	371,509	116,000,000
104	510	5,000	5,000	1,500,000
24	600	3,000	3,000	200,000

COUNTRY	REGION	DATE	TYPE OF DISASTER	NO. DEAD	NO. INJURED	NO. HOMELESS	NO. AFFECTED	TOTAL DAMAGE
Zaïre (cont'd.)	Kivu Province	8 Mar. 1968	landslide	154			600	
	Near Goma	10 Jan. 1977	volcanic eruption Nyirangongo	61	10		8,000	
				239	610	3,000	11,600	200,000
Zambia	Lusaka	Feb. 1978	floods	11	900	30,000	30,000	195,000
Zimbabwe	Umbeluzi River	3 Jan. 1966	floods					
		24 Dec. 1975	storm	11				

NOTE: This table has been compiled with data from various sources, since no reliable statistics on this subject exist. Although far from complete, these data give a general idea of the magnitude of losses sustained by African countries from natural disasters other than drought and desertification. Here is a list of the main sources used in preparing the table:

Government of Mauritius, Government Summary Report, 1979, December Cyclone.

Government of Tanzania, Emergency Operation for Relief Work for the 1982 Flood Victims in Kyela District - Mbyea Region.

"Le Monde," "L'Algérie, les autorités feront appel à des sociétés étrangères pour le relogement des sinistrés d'El Asnam," 31 october 1980.

League of Red Cross Societies, Tanzania Floods 1979, Circular 461, Geneva.

* Office of Foreign Disaster Assistance (OFDA), Agency for International Development (AID), Disaster History, Significant Data on Major Disasters World Wide, 1900-present, March 1983, Washington, D. C.

Case Report, Mozambique Floods, February 1975, Washington, D. C.

Case Report, Sierra Leone Tropical Storm, January 1975, Washington, D. C.

Summary Report: Djibouti Floods, October 1977, February 1978, Washington, D. C.

Summary Report: Rwanda Floods/Crop Losses, October 1974, Washington, D. C.

Summary Report: Zambia Floods, February 1978, Washington, D. C.

Tag-Eldeen, Mustafa, Disaster Mitigation Reduction of Flood Hazard in Tunisia, Royal Institute of Technology, Stockholm, 1981.

"Times," "Signs of Improvement in Relations between Morocco and Algeria," 29 October 1980.

UNDP, Sudan, September 1974, Flood Report.

UNDP, Tanzania, May 1974, Flood (letter dated 11 May 1974).

UNDRO, Mission Report: February 1975, Floods, Egypt.

Mission Report, February 1977, Cyclone Emilie, Madagascar.

Mission Report: December 1978, Cyclone Angèle, Madagascar.

Mission Report: February 1977, Floods, Mozambique.

Mission Report: September 1975, Floods, Sudan.

Wiser, Ben, Flood Prevention and Mitigation in the People's Republic of Mozambique, Disasters, Vol. 3, No. 3, pp. 293-306, Pergamon Press.

* Prime source.

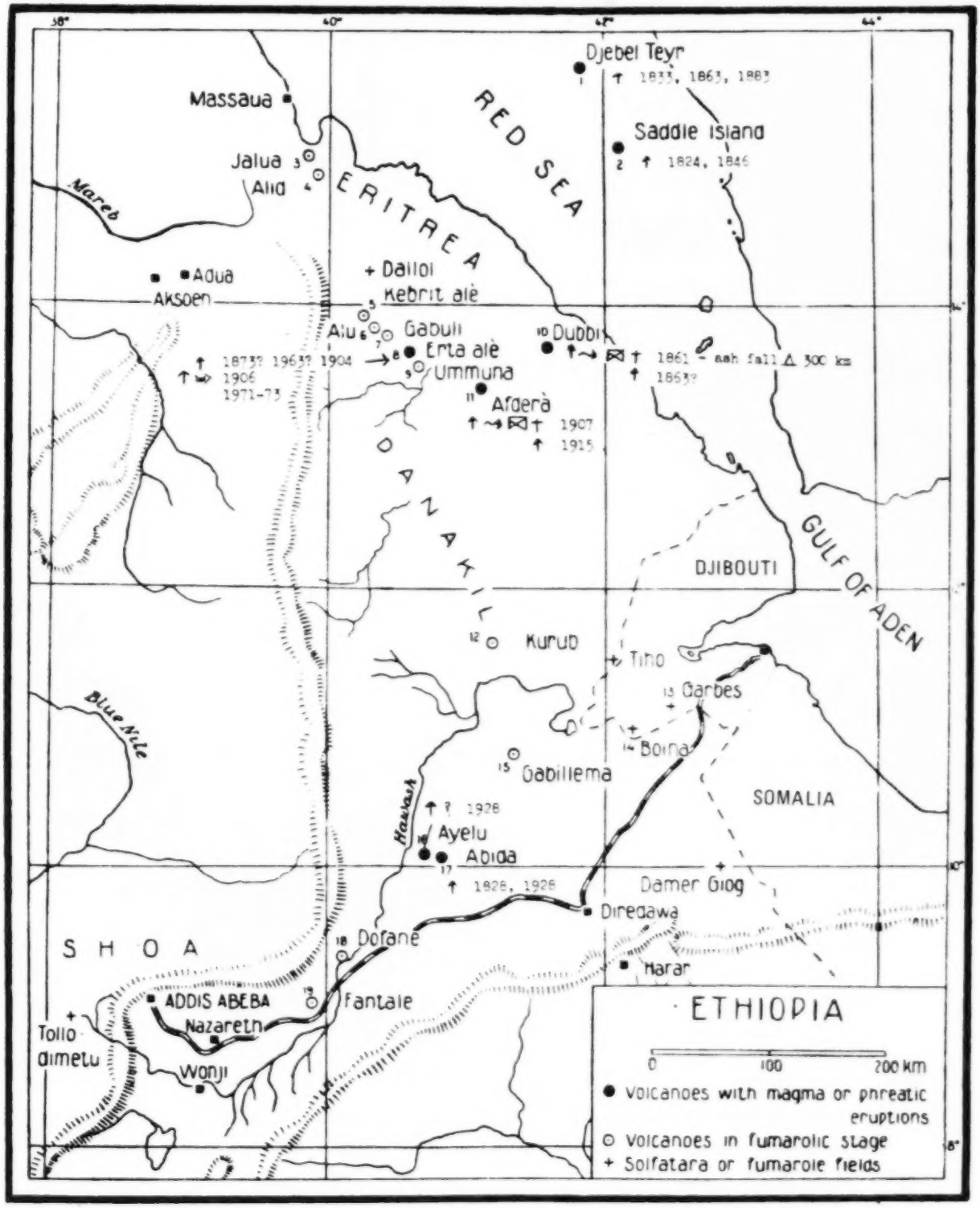


Fig. 1 Active volcanoes of Ethiopia, showing types and years of eruption.
(The boundaries and names on this map do not imply official endorsement or acceptance by the United Nations.)

LEGEND:

- Eruptions in a parasitic crater
- Eruptions in a radial fissure
- Normal explosions
- Lava flows
- Eruptions in a lava-lake
- Extrusion of a spine
- Phreatic explosions or mud eruptions
- Mud flows
- Destructions of arable land
- Casualties

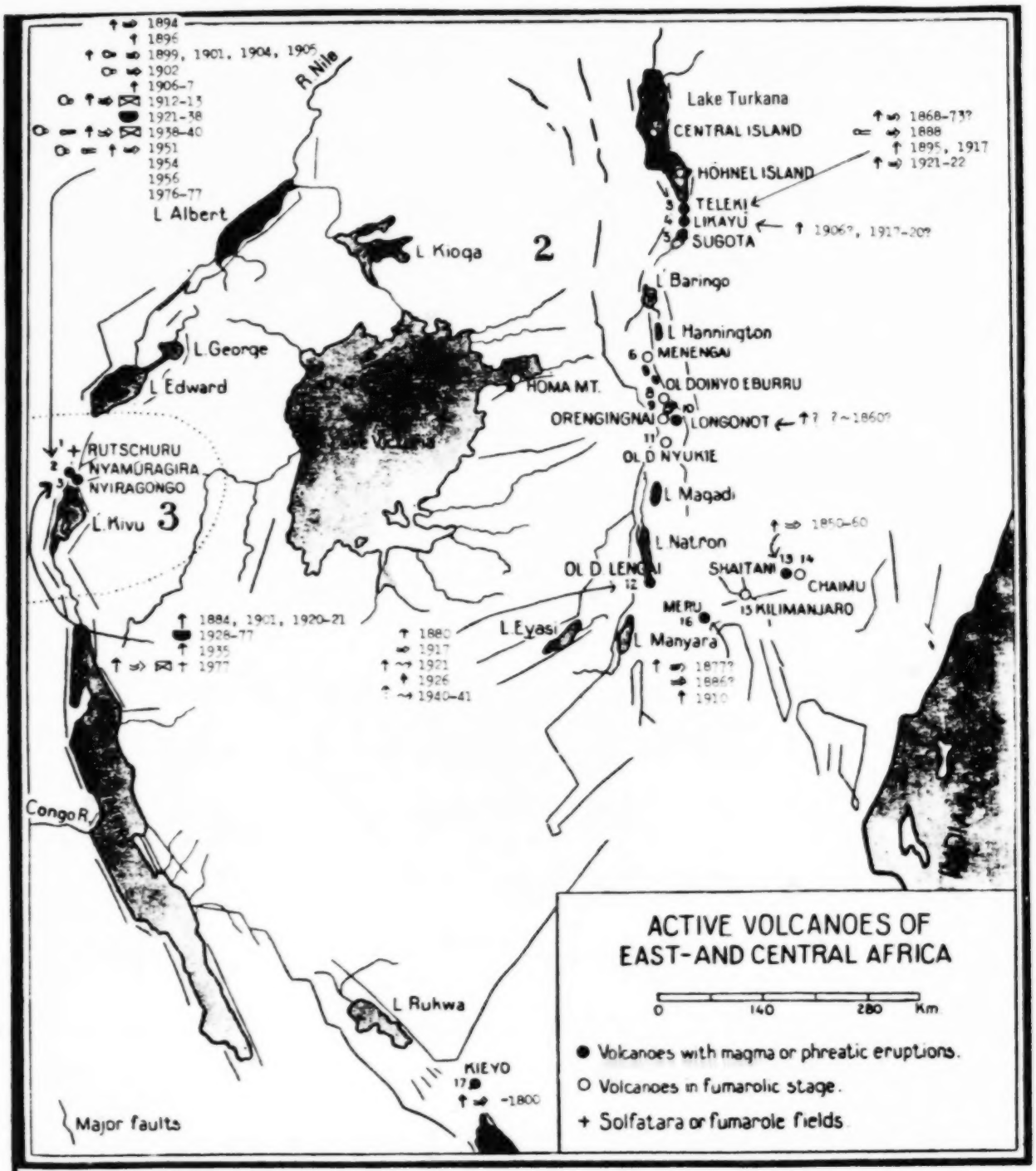


Fig. 2 Active volcanoes of East and Central Africa, showing types and years of eruption

(The boundaries and names on this map do not imply official endorsement or acceptance by the United Nations.)

LEGEND:

- Eruptions in a parasitic crater
- Eruptions in a radial fissure
- Normal explosions
- Lava flows
- Eruptions in a lava lake
- Extrusion of a spine
- Phreatic explosions or mud eruptions
- Mud flows
- Destructions of arable land
- Casualties